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THE THEORIES OF THE ORIGIN OF THE ANT- ARCTIC FAUNAS AND FLORAS.

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WHILE preparing a report on the fossil Tertiary invertebrates of Patagonia collected by the Princeton expedition, the writer was led to collect the literature on the subject of the resemblance of the southern faunas and floras (of South America, South Africa, Australia, and the Antarctic islands), and was very much surprised by the vague and sometimes incorrect representations of the existing theories relating to this fascinating zoögeographical question. Many authors do not quote their predecessors at all, while others refer to them only in a very general way, occasionally misstating their views or giving incorrect or defective quotations. I have, therefore, tried to collect everything that has been written on this topic, and think it will be worth while to give here a condensed report on the subject.

One of the first to call attention to the resemblance of southern life, in this case to that of the flora, and certainly the first to advance a theory, was Hooker.¹ He is of the opinion that we could possibly explain the fact of the existence of identical plants in southern lands widely distant from each other by the assumption that there was once a connection of these parts by land. This theory, first expressed very cautiously, and at that time much disputed, was again more energetically propounded by Hooker,² and, in the last paper, with reference to the Darwinian view of the origin of species.

In the course of time this theory was almost forgotten, at

¹ Hooker, J. D. *The Botany of the Antarctic Voyage of H. M. Discovery Ships Erebus and Terror (Flora Antarctica)*, Pt. ii (1847), p. 211.

² Hooker, J. D. Introductory Essay to the Flora of New Zealand (1853), pp. xxiii ff.; and On the Flora of Australia; its Origin, Affinities, and Distribution, *Botany of the Antarctic Expedition*, Pt. iii, vol. i (1859), pp. xvii and civ.

least it is not referred to by the next writers to be mentioned, whom we should regard as the founders of the theory of the Antarctica. The first of them is Ruetimeyer.¹ He states distinctly that we should take a part of the present faunas of South America, South Africa, and Australia for remnants of an old fauna that spread over a larger extent of the Antarctic continent, and that this Antarctic continent was the center of origin of a peculiar Antarctic fauna.

Practically the same idea — but without reference to Ruetimeyer — was set forth a little later by Hutton²; that is to say, he also assumed the former larger extension of the Antarctic continent, and its connection with the southern ends of the present continents.

In 1875 Gill,³ relying on his studies on fishes, constructed his Eogæa, which was apparently conceived as a large continental mass, embracing Africa, South America, and Australia; but no mention is made of the Antarctica entering it.

In opposition to all these theories, which construct land bridges, where there is now deep water, Wallace,⁴ consistent with his views on the permanence of land and oceans, entirely repudiates these opinions, and believes that the faunal elements common to the southern continents are remnants of a formerly more extensive distribution, and have been pushed into the southern ends of the land by the competition with other animals.

In favor of this view, Hutton⁵ abandons his first theory of a connection by an Antarctic continent. But he still maintains that there must have been a connection between Australia and South America, and he constructs a bridge across the mid-Pacific, assuming a large Pacific land mass, which was

¹ Ruetimeyer, L. *Ueber die Herkunft unserer Thierwelt*. Basel, 1867.

² Hutton, F. W. On the Geographical Relations of the New Zealand Fauna. *Trans. New Zealand Inst.*, vol. v (1873); reprint in *Ann. Mag. Nat. Hist.*, Ser. 4, vol. xiii (1874).

³ Gill, T. On the Geographical Distribution of Fishes, *Ann. Mag. Nat. Hist.*, Ser. 4, vol. xv (1875).

⁴ Wallace, A. R. *The Geographical Distribution of Animals*, vol. i (1876).

⁵ Hutton, F. W. On the Origin of the Fauna and Flora of New Zealand, *New Zealand Journ. Sci.*, January, 1884; reprint in *Ann. Mag. Nat. Hist.*, Ser. 5, vol. xiii, June, 1884.

joined, on the one side, to Australia and New Zealand, and, on the other, to Chili.

Von Ihering¹ takes up again the Antarctic communication, but at the same time he accepts, at least in part, Hutton's Pacific continent. According to him, a large land mass extended from South America across the Antarctic regions to Australia, from whence it continued into the Pacific continent, and even communicated with Asia (Archinotis). The Pacific continent was not directly connected with Chili.

While all these writers expressed their opinions on the Antarctica only in a very general way, Forbes² was the first to give it a more definite shape by drawing a map of it. He constructs his Antarctica by raising the land to about the present two thousand fathoms line, which results in an enormous extension of the Antarctic land masses.

In opposition to this, Hedley³ restricts the Antarctica considerably, and admits only narrow connections of it with the other continents. He does not think that New Zealand was ever joined to the Antarctica by land, and does not believe in Hutton's Pacific continent, although a part of the Pacific islands were once connected with Australia and New Zealand. Of the latter relations he gives a map in his second paper.

Finally, Osborn⁴ gives a map of the possible extent of the Antarctica by raising the land to the 3040 meters line. This attempt resembles somewhat that of Forbes, but shows a

¹ Ihering, H. von. On the Ancient Relations between New Zealand and South America (*Trans. New Zealand Inst.*, vol. xxiv, 1891), and Die Ameisen von Rio Grande do Sul (*Berlin. entomol. Zeitschr.*, Bd. xxxix, 1894). See also *Science*, v, December 7, 1900.

Von Ihering has referred to this subject in numerous other papers, and it is extremely difficult to collect all of them, since a large number have been published in out-of-the-way places. Lists of them have been given by himself in Engler's *Botanische Jahrbücher*, Bd. xvii (1893), p. 9, and *Science*, v.

² Forbes, H. O. The Chatham Islands; their Relation to a former Southern Continent (*Roy. Geograph. Soc. Suppl.*, vol. iii, 1893); abstract: Antarctica, a supposed former southern continent (*Natural Science*, vol. iii, 1893).

³ Hedley, C. Considerations on the Surviving Refugees in Austral Lands of Ancient Antarctic Life (*Proc. Roy. Soc. N. S. Wales*, 1895), and A Zoögeographic Scheme for the Mid-Pacific (*Proc. Linn. Soc. N. S. Wales*, 1899).

⁴ Osborn, H. F. The Geological and Faunal Relations of Europe and America during the Tertiary Period, etc., *Science*, April 13, 1900.

tendency to restrict the boundaries of this continent to reasonable dimensions, thus approaching Hedley's ideas.

Other writers have only added new facts to the material already at hand that favors the assumption of a former continental connection of the southern regions, and they have all accepted the general idea of Hooker and Ruetimeyer, without making any material change in it; therefore I do not consider it necessary to mention them here.

We may sum up all theories advanced, and put them into a table in the following way :

- I. Theories assuming a land connection between the respective parts.
This general idea was first expressed by Hooker (1847). It has been accepted by all subsequent writers except Wallace.
 1. The land bridge is placed across the present Antarctic continent, first by Ruetimeyer (1867) and by Hutton (1873). It was accepted by Von Ihering, Forbes, Hedley, Osborn.
 - (a) Forbes constructs his immense Antarctica (1893).
 - (b) Hedley restricts it to reasonable limits (1895).
 - (c) Osborn takes an intermediate standpoint (1900).
 2. Gill constructs his Eogæa, a continent uniting Africa, South America, and Australia, but leaving out the Antarctica (1875).
 3. Hutton connects Australia and South America by his mid-Pacific continent, but denies the existence of an Antarctic connection (1884).
- II. Theory of Wallace (1876) rejecting any land connections whatever between the respective parts.

I do not want here to go into any further detail, since my only purpose is to give an account of the existing theories with proper references, and to classify them according to their contents. But I may state here that in the forthcoming report on the Patagonian fossils mentioned above, I shall accept Hooker's general idea, as well as Ruetimeyer's Antarctica theory, with the restrictions put upon it by Hedley, and thus we may call it *the Hooker-Ruetimeyer-Hedley theory*.